MIGRATION OF THE MERLIN ALONG THE COAST OF NEW JERSEY

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Abstract - Merlins were captured along a migration route in New Jersey from 1968 to 1979. Sixty-one percent of 1550 Merlins captured at Cape May Point in autumn were female. Seventy-six percent of 105 Merlins captured at Sandy Hook in spring were female. Eight percent and 59% of the Merlins captured were adults at Cape May Point and Sandy Hook, respectively. The dho-gaza was the most effective capture device. Females migrated before males in autumn and vice versa in spring. Both sexes are captured more frequently after noon in autumn and spring, but many males were captured in the morning in spring. Timing of spring migration was more compressed. Mean wt and wing chord measurements were calculated. Adults were significantly heavier than immatures (t-Test, $P < 0.001$). In spring, Merlins were considerably heavier than in autumn. Most Merlins can be sexed by wing chord length and wt. Subcutaneous fat visible beneath the skin was estimated and was not correlated to mean wt. Band recoveries indicate a migration pathway along the Atlantic Coast with wintering in Florida and the Greater Antilles, but none from Cape May Point have been recovered in Central America or nothern South America. Some Merlins moved northward in autumn.

The Merlin (*Falco columbarius*) is of panboreal distribution. Most studies of the species have concentrated on the breeding season (Fox 1971; Oliphant and Thompson 1976; Newton et al. 1978) or systematics (Temple 1972a). Although most races are migratory (Peters 1964; Dementiev et al. 1966), and a few studies of Merlin migration have been published (Williamson 1954; Brown 1976; Thompson 1958), nothing has been published regarding migration of populations of eastern boreal North America *F.c. columbarius*.

This paper reports Merlin migration from data gathered during long-term raptor migration research at Cape May Point and Sandy Hook, New Jersey. Cape May Point is located at the southern tip of New Jersey where the greatest concentrations of migrating raptors in North America occur during the autumn migration (Dunne and Clark 1977; Dunne 1980). Sandy Hook is located on the south side of the New York Harbor and has been found to be a spring concentration point for raptors, especially small falcons (Clark 1978).

Methods

During 12 autumns, my cooperators and I have operated a raptor banding station at Cape May Point. During 1977-1980, a second banding station was operated during spring at Sandy Hook. Merlins and other species of raptors were captured at both locations using bownets, mist nets and dho-gaza nets (Clark 1970, 1981). Captured falcons were banded using U.S. Fish and Wildlife Service bands and in most cases were weighed to the nearest gram and wing chord measurements in mm were taken. Merlins were aged and sexed using the technique outlined in Temple (1972b). Data on wing chord and weight were used to verify sex determinations using the statistical computer program SAS Discriminate Function Analysis.

During 1978 and 1979, Merlins captured at Cape May Point were visually checked for subcutaneous fat on the sides of the breast, in the throat cavity and on the belly by blowing the feathers out of the way. Presence or absence of fat was recorded according to the coding scheme in Table 1.

Results and Discussion

Data were obtained for 1550 Merlins captured at Cape May Point during the years 1968-1979 (Table 2) and 104 at Sandy Hook during the years 1977-1980 (Table 3).

Age and Sex Ratios. — Only one exception was found to Temple's (1972b) key for ageing and sexing Merlins. Many immature plumage males had both gray and buffy colors in the light tail bands (N = 577), while immature females had only buffy tail bands (N = 852). Temple noted that immature males had only gray color in tail. Immature plum-

Table 1. Coding scheme for subcutaneous fat in captured Merlins.

Fat Class	Side	Throat		Belly
0	None	None		None
T (Trace)	A trace of fat is noted in any of the areas			
1	Slight-medium bulge	Present	(or)	Present
2	Medium-large bulge	Lined	and	Lined

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Table 2. Merlins banded Fall, 1968-1979, Cape May Point, New Jersey

	Males	Females	Total
Immature	574	812	1,386
Adult	41	77	118
Unknown	2	44*	46
Total	617	933	1,550

*Includes 43 unknown from 1971

Table 3. Merlins banded Spring, 1977-1980, Sandy Hook, New Jersey

	Males	Females	Total
Immature	3	40	43
Adult	22	39	61
Total	25	79	104

age females also had less well defined tail bands than those of males.

Merlins are sexually dimorphic with females larger than males. A plot of wt vs wing chord separated the sexes (Fig. 1), even though there is a slight overlap in either measurement between sexes. The data were also checked for accurate sex determination using discriminate function analysis. The same sex was selected by the program and the banders for every data pair of wing chord and wt.

Ninety-two percent of the Merlins captured in the autumn were first-year birds (Table 2). This age ratio was consistent with that of other raptors captured at Cape May Point; American Kestrel (*Falco sparverius*) 92.5% (N = 8091), Sharp-shinned Hawk (*Accipiter striatus*) 94.6% (N = 13,867), and Coopers Hawk (*Accipiter cooperii*) 92.7% (N = 756).

Age ratios reported for songbirds banded on the coast reflect the same phenomena (Robbins 1977).

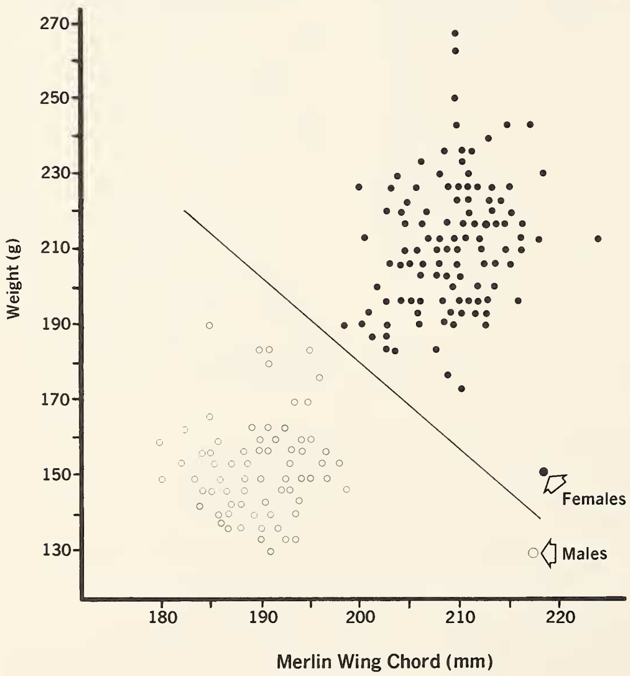

Figure 1. Comparison of wing chord and weight of migrant Merlins captured at Cape May Point, New Jersey.

Table 4. Merlins captured by type of trap.

Trap Type	Cape May Point, N.J. Males	Females	Total	Sandy Hook, N.J. Males	Females	Total
Dho-Gaza	264 (43%)	371 (41%)	638 (43%)	10 (40%)	31 (39%)	41 (39%)
Mist Net	170 (28%)	211 (23%)	381 (25%)	0%	2 (31%)	2 (%)
Bow Net	177 (29%)	333 (36%)	509 (33%)	15 (60%)	46 (58%)	61 (59%)
Other			4			0
Total	611	915	1,532	25	79	104

Presumably the best explanation is that immature raptors and songbirds are concentrated along the Atlantic coast during fall migration by the wind drift and leading line phenomena described by Mueller and Berger (1967). The higher winter mortality of immature raptors compared to adults (Newton 1979) may partially explain the higher percentage of adults in the spring sample (Table 3).

Capture samples (Tables 2 and 3) showed an unbalanced sex ratio in favor of females. At Cape May Point, 61% of the Merlins captured were females; at Sandy Hook, 76% . These samples are significantly different ($P < 0.001$) from each other and from the expected 50-50 sex ratio (Fox 1964) ($P < 0.001$). Possible explanations for the observed skewed ratios include capture bias, differential migration and differential survivability. Based on Merlins being caught and not being caught, there seems to be little or no sex bias in the capture techniques. If there is a different migration pathway for males, it is probably not over land, as no other raptor banding stations capture many Mer-

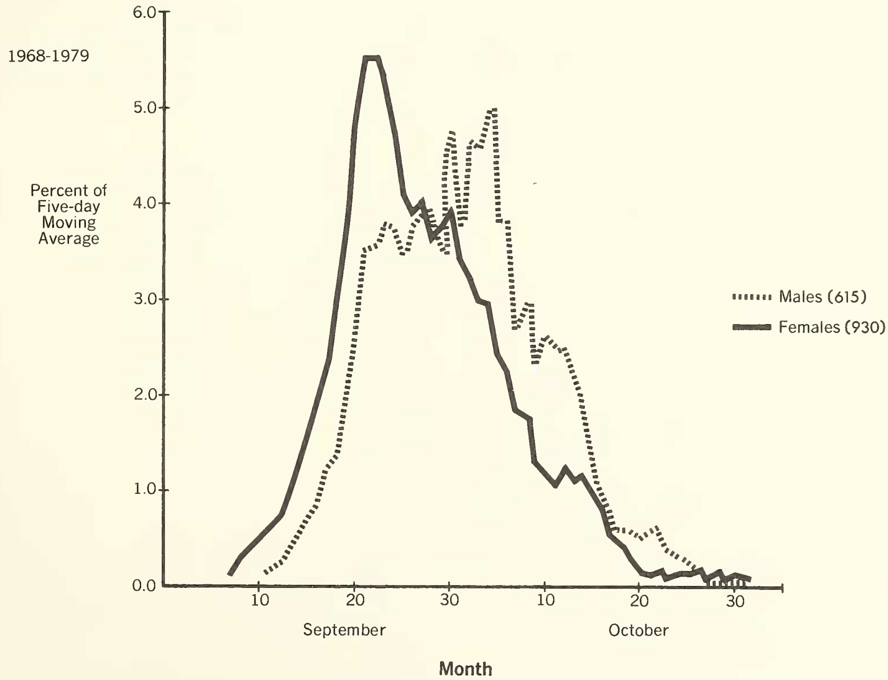

Figure 2. Merlins captured at Cape May Point, New Jersey, in the fall (1968 - 1979) by date by sex.

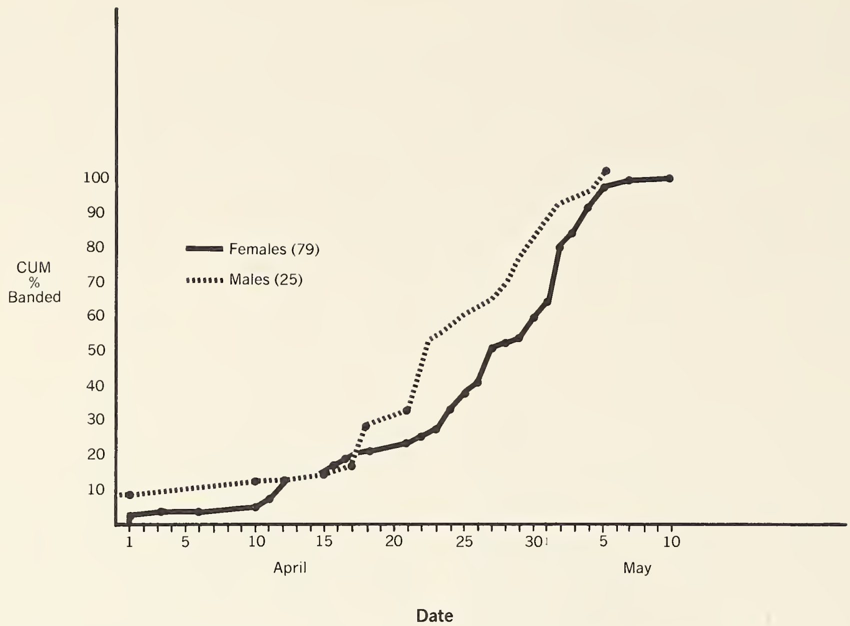

Figure 3. Merlins captured at Sandy Hook, New Jersey, in the spring by date by sex.

lins. Merlins have been reported in the fall migrating over water off the eastern coast of North America (anon. 1979). There are insufficient data to determine if there is differential survivability between males and females.

Capture Techniques — Merlins were captured by 3 types of traps (Table 4). The modified dho-gaza (Clark 1981) is the most effective trap for capturing Merlins. There are minor differences in percentages by capture method among the 4 to 5 different stations at Cape May Point caused by terrain differences. Generally, dho-gazas (and mist nets) are more effective when there is a dark background behind them and bow nets are more effective in more open locations. Differences between the capture technique percentages of Cape May Point and Sandy Hook are probably due to differences in terrain. The Sandy Hook stations are in much more open terrain with little backdrop available.

Diurnal and Seasonal Timing — The Merlin was one of the earlier autumnal migrants at Cape May Point, arriving in numbers by September 10, and completing the passage by mid-October (Fig. 2). Females migrated earlier in the season than males and peaked earlier (Fig. 2). Rosenfield and Evans (1980) theorize that migrating immature female Sharp-shinned Hawks precede males because of their dependence on larger avian prey. My data for Merlins support their hypothesis, as the Merlin also subsists almost entirely on birds and females migrate first.

Males precede the females in spring (Fig. 3). This is consistent with behavior of other migrant species with the adult males arriving on territory first (Roest 1957). The spring migration period spanned a shorter time than the autumn period. The autumn migration "season" for Merlins is over a month while the spring migration period lasts only about 15 d. In spring they do not appear in numbers until after 20 April and most have passed by 5 May.

There is very little difference in the time of day the sexes are captured at Cape May Point (Fig. 4). In general, the data support the observation that Merlins are more plentiful in the afternoon.

Migrating Peregrine Falcons (*Falco peregrinus*) have been characterized by having 3 different flight characteristics during the day (Cochran 1975). First, from predawn to the time of thermal formation, they hunt using powered flight in the desired migration direction at an altitude of around 30m.

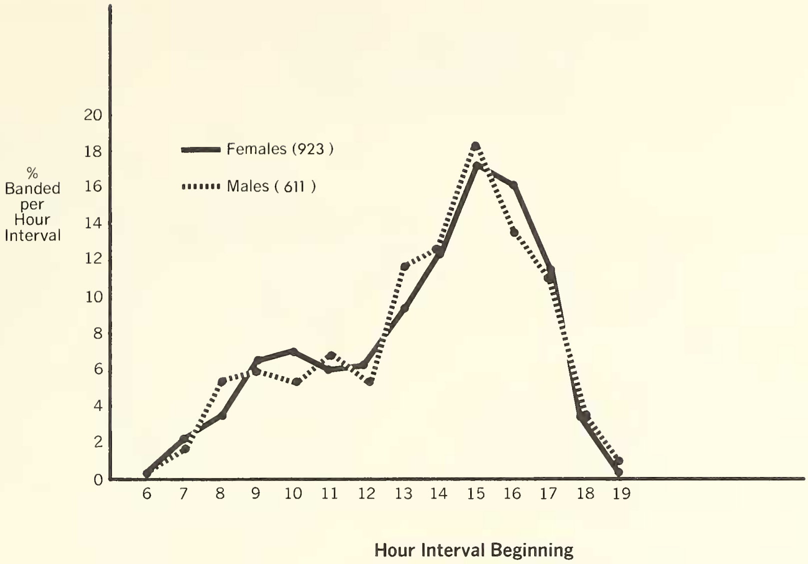

Figure 4. Merlins captured at Cape May Point, New Jersey, in the fall by time of day by sex.

During mid-day, they utilize thermals in the manner of most migrating raptors. In the afternoon, when thermal production slows down or ceases, they begin a low-level hunting flight, generally in a random direction. I believe that the Merlins migrating along the Atlantic Coast use similar strategies. On many occasions Merlins that had perched for the night on snags at Cape May Point were not present the next morning at first light (Dunne, pers. comm. 1981). The Merlins may have begun migrating using powered flight hours before sunrise, changed to thermals later in the morning, and finally, when thermal formation weakened later in the afternoon, they dropped to low altitudes

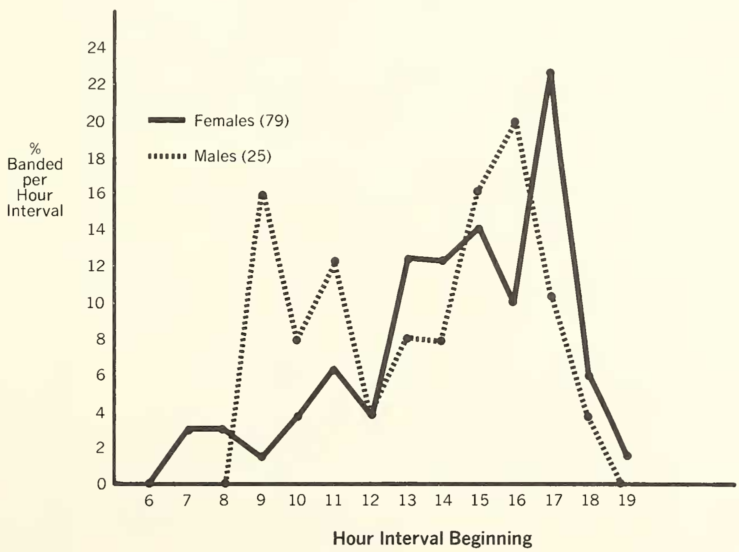

Figure 5. Merlins captured at Sandy Hook, New Jersey, in the spring by time of day by sex.

Table 5. Mean weight and wing chord of Merlins banded in the Fall at Cape May Point, New Jersey.

		Adult*	Immature*	t-Test for Difference (P<0.001)
Weight	Male	158.6g (40) ± 11.6	152.7 (506) ± 10.7	Yes
	Female	217.7g (72) ± 14.3	211.3 (27) ± 15.6	Yes
Wing Chord	Male	190.4 (40) ± 4.2	190.2 (546) ± 5.0	No
	Female	211.7 (73) ± 3.8	210.4 (759) ± 4.3	Yes

*(Sample size in parenthesis)Mean ± SD

and began low-level hunting flight. Merlins were captured in numbers late in the day, long after other raptor species have ceased migrating. Merlins were also captured in numbers on overcast, drizzly days when thermals, if present, were weak. The situation is not quite so clear when one looks at the equivalent data for the spring captures at Sandy Hook (Fig. 5), probably due to the small sample size.

Measurement Data — Mean wt and wing chord measurements were calculated for Merlins captured at Cape May Point (Table 5) and Sandy Hook (Table 6). Adults of both sexes were significantly heavier than immatures (t-Test, $P < 0.001$). Only for females did adults have significantly longer wings than immatures. Interestingly, Temple (1972b) reported no significant differences in age class measurements of wing chord for *F.c. columbarius*. The mean wing chords reported by Temple were not significantly different from my data (t-Test, $P > 0.001$). The spring data (Table 6) show almost the identical mean for wing chords as in the fall, but considerably heavier wt than in the fall.

Fat — There are few references to fat deposition in raptors (Newton, pers. comm. 1977). Gesseman (1979) documented and quantified fat deposition in American Kestrels by sacrificing them and extracting fat. He attributed changes in fat deposition to migrational needs.

Merlins were checked for fat deposition during autumn 1978 and 1979. Of the 279 Merlins in-

Table 6. Mean weight and wing chord of Merlins banded in the Spring at Sandy Hook, New Jersey.

		Adult*	Immature*	t-Test for Difference (P < 0.001)
Weight	Male	169.0 (22) ± 13.7	155.9 (3) ± 10.2	No
	Female	243.6 (39) ± 21.6	234.4 (40) ± 13.4	Yes
Wing Chord	Male	190.1 (22) ± 3.4	188 (3) ± 2.4	No
	Female	211.9 (39) ± 4.4	210.5 (39) ± 3.8	No

* (Sample size in parenthesis) * Mean ± SD

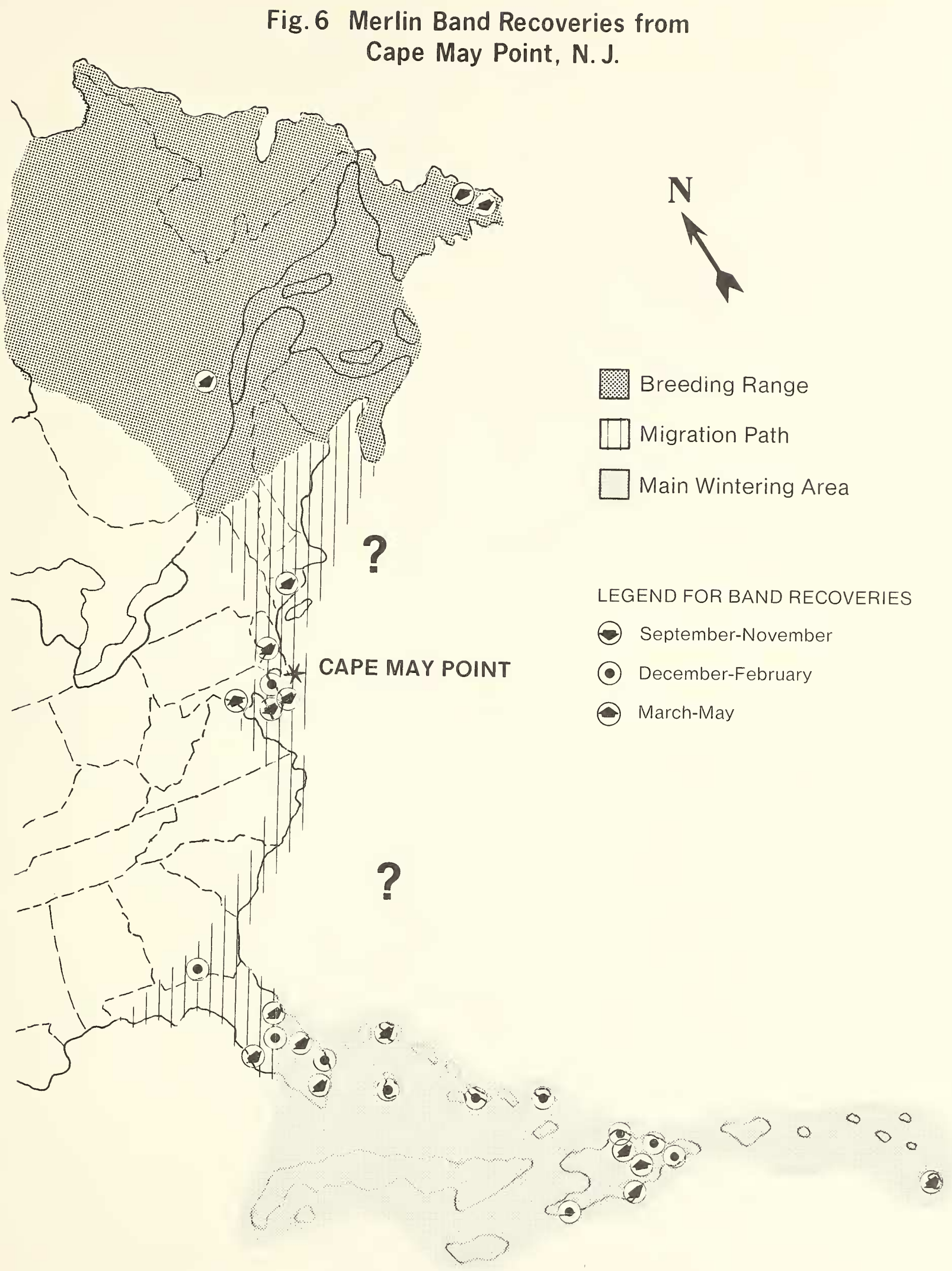

Figure 6. Map of recoveries from Merlins banded at Cape May Point, New Jersey.

spected, 232 had at least a trace or more of fat. Weight was not correlated with increasing fat deposition. A possible explanation for this is that crop and stomach contents were not measured. Oliphant (pers. comm. 1981) indicated that Merlins are capable of eating more than 50 g at one time.

Band Recoveries — Band recovery locations of Merlins from Cape May Point are plotted in Fig. 6. Breeding range in Fig. 6 was hypothesized based on the breeding range of the Merlin given by the AOU Checklist (5th Ed.) and the few recoveries from breeding areas. This breeding area is the probable origin for the Merlins occurring at Cape May Point.

The main flight path of Merlins during autumn migration is along the east coast of North America based on counts at hawk watches (Dunne 1980). Few Merlins are encountered on migration in eastern North America other than along the Atlantic coast (Soucy 1976; Field 1978; Holt 1980). Merlins also migrate across the open ocean (McLean and Williamson 1958), are regularly encountered at sea off the east coast of North America in the autumn (anon. 1979), and are casual in Bermuda (Friedman 1950). It is not known what fraction of the eastern Merlin population uses an over water migration pathway in the autumn.

Based on band recoveries, the main wintering area for eastern Merlins is Florida and the Greater Antilles (Fig. 6). A few individuals also winter along the Atlantic coast north to New England. Two recoveries of Merlins banded by other studies in autumn along the Atlantic coast and recovered in Cuba support this theorized winter range. The AOU Checklist (1957:121) gives the wintering range of the eastern Merlin as: ". . . from southern Texas (Brownsville), southern Louisiana (New Orleans), Alabama (Anniston), South Carolina and Georgia south through Mexico, Central America, and the West Indies to northern Peru, Columbia and northern Venezuela, casually north to Nebraska, Iowa, Illinois, Indiana, Ohio, southern Ontario, southern Quebec and Maine."

Since the Cape May Point winter recoveries are from a much more limited area, Merlins from the more western part of the breeding range must be wintering in the other sections. Band recoveries of this species from Latin America tend to support this. Three recoveries from Wisconsin bandings were in northern South America, 2 in Columbia and 1 in Equador (however, 1 recovery from Wisconsin was from the Dominican Republic). The only Central American recoveries are 1 banded in Ontario and recovered in Honduras and another banded in the Northwest Territories and recovered in Costa Rica (data from Bird Banding Lab., U.S. Fish & Wildlife Service).

The majority of the band recoveries were from females (23 out of 29 or 79%), but the banding ratio is 60% female. A possible reason for this could be due to band retention differences between the sexes. Females are given a size 4 lock-on band, while the males have been given size 3A butt-ended bands. Dunne (pers. comm. 1980 has observed male Merlins successfully removing bands within 15 minutes after being banded. We have recently begun to use USFWS size 3 bands on the males, which are stiffer and should result in better retention.

These 29 recoveries from a banding sample of 1550 yield a recovery rate of 1.8%. Fyfe and Banasch (1981) reported a recovery rate of 1.97% from banding a similar number of Merlins. Thompson (1958) reported a 15% recovery from Great Britain banding and Smith (1981) reported a 16.7% rate in Alberta. However, these populations are non-migratory, and the majority of recoveries in both studies were within 64 km of the banding site. Icelandic Merlins migrate through the British Isles and winter there as well as in southwestern Europe, but no band recovery percentages have been reported (Williamson 1954; Brown 1976).

Most band recoveries of Merlins banded at Cape May Point are from dead birds. Nine had been shot; 7 of these in the Caribbean where it is not against the law to shoot raptors. Four were found dying, probably a result of striking windows, buildings or wires, and 12 were found dead, with the cause of death not obvious.

Two Merlins were recovered north of Cape May Point shortly after being banded, 1 in Connecticut. This may indicate that the autumn migration is not a simple north to south movement. Another was captured alive and released 6 days after banding at Cape Charles, VA. Three were recovered wintering in the U.S. and 8 in the Greater Antilles. There was 1 spring recovery inland from the coast. There are few summer recoveries of this species in the breeding range, probably due to remoteness of the breeding area and the Merlins' secretive behavior. There have been no recoveries of Merlins banded at Sandy Hook and no Merlin recaptures that were previously banded at Cape May Point.

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